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Device for the assembly of small, notably electronic, components

The invention relates to a hand tool for the assembly of small, notably electronic components in accordance with the preamble of Claim 1.

A hand tool of this type is prior art, for example from WO89/04547. The hand tool displays a shaft equipped with a handle and a front head part, in which a spindle which houses a vacuum tool is mounted. The axis of the spindle or vacuum tool is positioned at a constant angle to the axis of the shaft. The spindle is fitted with a turning knob at its upper end, by means of which a turning displacement of the spindle and thereby also of the vacuum tool occurs for the purposes of positioning the suctioned component. The turning knob is normally actuated by the index finger, while the hand tool or the handle thereof is held between the thumbs and the other fingers. The middle finger underneath is longer than the index finger, which can result in the view of the component and the object onto which it is to be mounted becoming obscured. There is the risk of the component and/or the object onto which it is to be mounted being touched by the lower fingers, which is undesirable. In order to prevent this, the operator must concentrate especially hard. This often results in an unnatural posture which is tiring, and can in turn affect the quality of the work.

The invention in question is based on the problem of creating a hand tool of the type described above which makes comfortable and troublefree handling possible.

This problem is resolved according to invention by means of a hand tool with the characteristics of Claim 1.

Additional advantageous designs of the hand tools according to invention form the substance of the subordinate claims.

As the result of the fact that the axis of the turning knob is arranged at a distance with respect to the spindle or vacuum tool axis and is offset in the direction of the handle, whereby a driving connection exists between the turning knob, the risk of an obscured view with respect to the component and the object onto which it is to be mounted and of undesirable contact during mounting is largely eliminated and an ergonomically advantageous design of the hand tool is achieved.

The driving connection between the turning knob and the spindle is advantageously realised by means of straight-toothed spur wheels assigned to the turning knob and the spindle, which are linked via an intermediate wheel. With a spindle which can be adjusted axially as the result of the vacuum tool being touched by the component, the spur wheel connected to the spindle can preferably form part of a switchgear to pass a signal to an external controller for switching on and off the vacuum, which can, for example, be in the form of a mechanical contact pair or an electronic sensor. The straight toothing of the spindle wheel is especially advantageous, since when the spindle is adjusted axially, no additional spindle rotation arises. Both the driving connection and the on-off control of the vacuum occur in a simple fashion.

For preference the flexible link of the electropneumatic connection between the vacuum tool and the controller extending between the shaft and the external controller comprises an external tube made of electrically-conductive material, which solves the problem of electrostatic charging, which can for example be intensified as the result of rubbing the flexible link on a support, which can even result in damage to the components being handled and severely interferes with the operation. Advantageously, the tube simultaneously forms the pneumatic link, i.e. the vacuum channel, through which the electrical wires, preferably in the form of an insulated flex and an uninsulated cable, preferably steel cable, are also passed.

As the result of the fact that the flexible link is preferably connected to the controller via an electropneumatic connector, which displays both pneumatic and electrical connection elements, a simpler, autonomous assembly of the hand tool and of the controller is enabled. In addition the hand tool can be specially packed separately from the much larger control box for transport and also be supplied as a replacement part.

In a preferred design of the hand tool, the cable forming one electrical connector is firmly anchored, at one end in the shaft and at the other in the electropneumatic connector and is provided as a means of relieving strain on the other connections (tube, flex), thus preventing them from being unpredictably pulled out of the shaft or out of the connector. At the same time it serves as an earth and conducts electrostatic charging through the wall of the tube, which is made from electrically-conductive material.

For especially ergonomic handling, the shaft is fitted with an end piece with an extended cross-section, by which the hand tool can be mounted, when not in use, in a fork-shaped holder which can be fixed in an ergonomically favourable position, preferably on the control housing.

One design example of the device according to invention is shown in the drawing and described in more detail below. Shown are:

Fig. 1 view of a hand tool in the resting position, mounted in a holder fixed onto a control housing;

Fig. 2 on an enlarged scale and in section, a front part of the hand tool shown in Fig. 1 in a working position;

Fig. 3 on an enlarged scale and partial section, a rear part of the hand tool shown in Fig. 1 in the working position according to Fig. 2, with a flexible electropneumatic link and an inner part of an electropneumatic connector;

Fig. 4 an electropneumatic connector of the electropneumatic link according to Fig. 3 in frontal view, seen in the direction of the arrow S; and

Fig. 5 a socket provided for the connector according to Fig. 4 in frontal view.

Fig. 1 shows a hand tool 1 for the assembly of small, notably electronic components, which is mounted in the resting position, i.e. when not in use, with its rear end piece 2, which has an extended cross-section, in a fork-shaped holder 3. The holder 3 is fixed onto an upper wall 4' of a housing 4, in which a controller 5 for the electropneumatic actuation of the hand tool 1 or for switching the vacuum on and off is accommodated. The holder 3 is preferably screwed onto the housing 4 and can be removed from this, for example if the whole piece of equipment is to be transported (in Fig. 1 only one fastening axis is indicated, the fastening screw itself is

not visible in Fig. 1). While Fig. 1 shows a right-angled position of the U-shaped slot 6 of the holder 3 with respect to a front housing wall 4'', it is also possible to fasten the holder 3 in a different position, pivoted about the fastening axis A, in which the U-shaped slot 6 stands at an angle to the front housing wall 4''. In this way, the hand tool is kept at the ready in the best possible way ergonomically, depending on the positioning of the controller 5 on the workbench, i.e. this can be optimally adjusted depending on whether the controller 5 is placed to the left or right of the operator, or whether the operator is right-handed or left-handed.

The hand tool 1 displays a shaft 10, which is provided with a handle 11. In a head part 12 of the hand tool 1 a vacuum tool 13 is mounted, as described in detail below with the aid of Fig. 2. The shaft axis B and the tool axis C form a constant angle. When the tool axis C is vertical to a working surface, the shaft axis B is preferably inclined at an angle of 45° to the working plane (Fig. 2 shows this position). The vacuum tool 13 can be turned by means of a turning knob 40, which is located in the immediate proximity of the handle 11 fitted with gripping surfaces 11', and which, when grasped by the handle 11, is usually actuated by the index finger. The transmission of the turning movement from the turning knob 40 to the vacuum tool 13 is also described in full below with the aid of Fig. 2.

On the end of the shaft 10 facing away from the head part 12 and fitted with the end piece 2 - as can be seen in particular from Fig. 3 - is fixed a flexible connector 15 of an electropneumatic connector 14 between the vacuum tool 10 and the controller 5. The flexible connector 15 (in Fig. 1, some parts are only sketched in the diagram by means of dashes) is equipped with an electropneumatic connector 17 which can be seen in Figs. 3 and 4, and which can be inserted into a socket 18 (Fig. 5) built into the housing 4 of the controller 5.

In accordance with Fig. 2 the basically sheath-shaped shaft 10 is provided with a lower carrier part 20, on which the head part 12 is mounted and fastened by means of a fixing screw 22. The head part 12 displays a bore hole 25, in which a spindle bushing 26 is inserted. A spindle 27 rests in the spindle bushing 26 in such a way that that it can be both pivoted and displaced axially. The vacuum tool 13 is inserted into an axial recess 28 of the spindle 27 and held fast by the spindle in the manner of a collet chuck. An axial vacuum channel 30 of the vacuum tool 13 runs into a part 28' of the recess 28 with a smaller diameter, which is connected via a radial connecting bore 31 with an annular space which lies between the spindle sheath 26 and

the bore hole 25 of the head part 12. On the other side a bore hole 33 which is placed at right angles to the tool axis C or to the axis of the bore hole 25 in the head part 12 runs into the annular space 32. A pipe 36 which forms a vacuum channel 37, displaying two parts inclined at an angle to each other, made of electrically-conductive material, protrudes at one side into the bore hole 33 of the head part 12 and on the other side into a vacuum tube 39 coaxial to the shaft axis B mounted in the sheath-shaped shaft 10.

Parallel to the spindle or tool axis C and closer to the handle 11 of the shaft 10, a fixed axis 42 is mounted in a bore hole 41 of the head part 12 for a drive wheel 44 linked to the turning knob 40 such that it will not rotate. The turning knob axis is referred to in Fig. 2 as D. If necessary the bore hole can be provided both for the fixed axis 42 as well as for the fastening screw 22. The spindle 27 is fixed to a spindle toothed wheel 45 such that it will not rotate. The spindle toothed wheel 45, via an intermediate wheel 46, has a driving connection with the drive wheel 44. The intermediate wheel 46 is mounted so as to rotate on a further intermediate axis 47 mounted in the head part 12 fixed in a bore hole 47'. Thus the spindle 27 which houses the vacuum tool 13 also has a driving connection with the turning knob 40, whereby the direction of rotation of the turning knob 40 is the same as the direction of rotation of the spindle 27. All toothed wheels 44, 45 and 46 are in the form of straight-toothed spur wheels.

The spindle 27 displays a further axial recess 48 on the end facing away from the recess 28, from which a sphere 50 protrudes and is pressed upon by a spring 49 on a cover 51 connected to the head part 12. The sphere 50 effects practically frictionless support for the turning spindle 27 on the cover 51.

The electrical part of the electropneumatic connector 14 between the vacuum tool 13 and the external controller 5 comprises an insulated flex 53 together with an uninsulated cable 54 made from electrically-conductive material, preferably made of steel. The flex 53 which is guided through the sheath-shaped shaft 10 to the perimeter of the vacuum tube 39 is linked electrically to a contact plate 55 mounted beneath toothed wheels 44, 45 and 46, placed on an upper surface 56 of the head part 12. The spindle toothed wheel 45, with its lower fore-part, forms a linked contact surface 57 with the contact plate 55. An upper fore-part 58 of the spindle sheath 26 lies at a distance from the contact plate 55.

The cable 54 which is also guided through the sheath-shaped shaft 10 to the perimeter of the vacuum tube 39 is electrically connected to the tube 36. The tube 36 is electrically connected via a spring 59 guaranteeing a secure contact with the spindle bushing 26, the spindle 27 and the spindle toothed wheel 45. In the position shown in Fig. 2 for the spindle 27, the electrical circuit is closed by the contact surface 57 of the spindle toothed wheel 45 resting on the contact plate 55.

According to Fig. 3 in the rear area of the sheath-shaped shaft 10 a nipple which is also in the shape of a sheath is inserted into the interior of the shaft, which rests on a shaft shoulder 63 and is held fast via a spacer sheath 64 by the end piece 2 screwed into the end of the shaft. A tube 65, projecting on one side into the vacuum pipe 39 and on the other side into the nipple 62 connects the two parts. Both the flex 53 as well as the cable 54 are guided through the nipple 62 to the perimeter of the pipe 65 so as to form a seal and at least the cable 54 is anchored fast therein. A tube 66 is slipped onto one lug 62' of the nipple 62 as an integral part of the flexible link 15 to form a seal and fixed onto this. The tube 66 which with its interior forms a vacuum channel 67, through which the electrical wires (flex 53, cable 54) are guided to the connector 17 is made of electrically-conductive material or at least material which displays electrically-conductive particles. This could for example be silicon with added graphite.

The end piece 2 screwed into the end of the shaft is essentially in the form of a funnel and is equipped with a rimless internal surface 68, on which the tube 66 leading out of the shaft 10 can be carefully attached.

The end of the tube 66 facing away from the shaft 10 is slipped onto a connection pipe 70 of the electropneumatic connector 17 so as to form a seal and attached thereto. The connection pipe 70, preferably made of brass, forming a vacuum channel 72, is fixed into a connector part 71 and projects out of this with its part 70'. The part 70' is provided for insertion into a corresponding counterpart 75 of the connector 18 (Fig. 5), where a seal 73 secures the pneumatic connection of the connector 17 with the socket 18.

On the perimeter of the connector pipe 70, electrical contact pins 77, 78 are built into the connector part 71. The socket 16 displays corresponding connection openings 79, 80 for the

contact pins 77, 78 (Fig. 5). The electrical wires (flex 53, cable 54) are guided out of the connector pipe 70 so as to form a seal and each anchored in one of the contact pins 77, 78 respectively.

The parts of the electropneumatic connector 17 shown in Fig. 3 are accommodated in a connector shell not shown in Fig. 3, which is referred to in Fig. 4 as 81 and can be screwed onto the socket 18.

The length of the cable 54 which is anchored at one end in the nipple 62 and at the other in the contact pin 78 is less than the length of the flex 53 between the nipple 62 and the contact pin 77. In this way the cable 54 acts as tension reliever for the other parts of the flexible connector 15 (tube 66, flex 53), so that for example if the hand tool 1 unintentionally falls from the workbench and ends up hanging down by the flexible connector 15, there is no risk that these parts could be pulled out.

The functional methods and the special advantages of the hand tool 1 according to invention are described below.

The hand tool is gripped by the operator by the handle 11 and placed in the position shown in Fig. 2. When the component to be handled is touched with the vacuum tool 13 the vacuum tool 13 is pressed upwards with the spindle 27 in the spindle sheath 26 against the force of the spring 49. The spindle toothed wheel 45 is also raised with the spindle 27 and thus contact between the contact area 57 and the contact plate 55 is interrupted. This breaking of the electrical circuit sends a signal to the controller 5, the vacuum is switched on and the component is suctioned onto the vacuum tool. The operator can now turn the turning knob 40 with his index finger in order to achieve the desired position of the component suctioned onto the vacuum tool 13. As the result of the fact that according to invention the tool axis C is placed at a distance from the turning knob axis D, it is guaranteed that the turning knob 40 which is in the immediate vicinity of the handle 11, can easily be reached with the index finger and the middle finger lying underneath thus does not interfere with visibility with respect to the component or to the object onto which the component is to be mounted. In this way, too, the risk that the component and/or the object may be unintentionally touched with

the middle finger and possibly even damaged, is largely eliminated. The operation is considerably facilitated for the operator as a result.

Another improvement of the operation is achieved by the fact that not only the shaft 10 itself, but also the tube 66 of the flexible link 14 are electrically-conductive. The uninsulated cable 54 not only serves to relieve strain, as already mentioned, but also as an earth and discharges the electrostatic charging, which can be intensified for example by the rubbing of the flexible link 14 on a support, through the electrically-conductive tube 65. The result of this is to guarantee that the operation proceeds smoothly and quietly and the risk of damage to the components is eliminated. It would, however, also be possible to pass the electrical wires and the vacuum tube, which were previously produced from non-conductive material, e.g. from polyurethane or another synthetic material, through a metallic mesh tube and to discharge the electrostatic charges thereby. The solution according to invention in which the tube 66 made of electrically-conductive material simultaneously forms the pneumatic link, i.e. the vacuum tube and surrounds the electrical wires, is however more advantageous in that there is no risk of „snagging", pulling off, and thus nor any risk of injury as there is with a mesh.

The fact that the flexible link 14 is not directly installed into the controller 5 but can be connected to the latter by means of an electropneumatic connector 17 allows for simpler, independent assembly of the hand tool 1 and of the controller 5. Furthermore the hand tool can be specially packaged for transport separately from the much larger control box and also be supplied as a replacement part.

In the design example illustrated, the spindle wheel 45 in the form of an axially adjustable spur wheel forms part of a mechanical contact pair 55, 57. But it would also be possible to use an electronic sensor to send a signal to the controller 5, one part of which is formed by the spindle wheel 45. So for example a coil could be built into the cover 51, whose inductance could be changed by the axial adjustment of the spindle wheel 45.

In place of the spur wheel driving connection between the turning knob 40 and the spindle 27, a friction or belt drive could also be used.

Instead of the fork-shaped holder 3, obviously a different, for example a saucer-shaped, holder could be attached to insert the hand tool on the control housing, although the solution according to invention, as already mentioned, does allow for especially advantageous ergonomic manipulation.

The tool according to invention is especially conceived as a tool for mounting microelectronic assemblies, but could also be used in fine mechanics or optics.